CLAIMS

1. A fuel cell system using a liquid fuel containing an alcohol comprising:

a fuel cell main body including a solid polymer electrolytic membrane, and a fuel electrode and an oxidant electrode attached to said solid electrolyte membrane;

a container containing said liquid fuel;

a polymer membrane having proton conductivity and provided inside of said container or at the wall portion of said container; and

a concentration detection unit which detects the alcohol concentration of said liquid fuel in said container based on the alteration of the proton conductivity of said polymer membrane when said polymer membrane is immersed with said liquid fuel.

2. The fuel cell system according to claim 1,

wherein said concentration detection unit includes a pair of electrode terminals attached to said polymer membrane, a resistance measurement unit which measures the resistance value between said electrode terminals, and a concentration calculation unit which calculates the alcohol concentration of said liquid fuel based on the resistance value measured by said resistance measurement unit.

3. The fuel cell system according to claim 2,

wherein said electrode terminals of said concentration detection unit are placed at outside of said container.

4. The fuel cell system according to claim 2 or claim 3, wherein said concentration detection unit includes a hydrophobic membrane covering said electrode terminals.

5. The fuel cell system according to any one of claims 1 to 4, wherein a portion of said solid polymer electrolytic membrane is used as said polymer membrane.

6. The fuel cell system according to any one of claims 1 to 5, further comprising a plurality of polymer membranes having different proton conductivities with respect to temperature or pH,

wherein said concentration detection unit detects the alcohol concentration in said liquid fuel based on the respective alterations of the proton conductivities of said plurality of polymer membranes in consideration of temperature or pH of said liquid fuel in said container.

7. The fuel cell system according to any one of claims 1 to 6, wherein said polymer membrane includes a protonic acid group.

8. A fuel cell system using a liquid fuel containing an alcohol comprising:

a fuel cell main body including a solid polymer electrolytic membrane, and a fuel electrode and an oxidant electrode attached to said solid electrolyte membrane;

a container containing said liquid fuel;

a polymer membrane provided inside of said container or at the wall portion of said container and changeable in size in accordance with the concentration of the alcohol concentration of said liquid fuel when being immersed with said liquid fuel; and

a concentration detection unit which detects the alteration degree of the size of said polymer membrane and detects the alcohol concentration of said liquid fuel in said container based on the alteration degree of the size.

9. The fuel cell system according to claim 8,

wherein said concentration detection unit includes a strain gauge attached to said polymer membrane, a resistance measurement unit which measures the resistance alteration of said strain gauge, and a concentration calculation unit which converts the resistance alteration measured by said resistance measurement unit into the alcohol concentration of said liquid fuel.

10. The fuel cell system according to claim 8 or 9,

wherein a portion of said solid polymer electrolytic membrane is used as said polymer membrane.

11. The fuel cell system according to claim 8,

wherein said concentration detection unit includes a capacitor composed so as to sandwich said polymer membrane, an electric capacity measurement unit which measures the electric capacity of said capacitor, and a concentration calculation unit which detects the size alteration of said polymer membrane based on the alteration of the electric

capacity measured by said electric capacity measurement unit and converts the size alteration degree into the alcohol concentration of said liquid fuel.

12. The fuel cell system according to claim 8,

wherein said concentration detection unit includes a quartz oscillator attached to said polymer membrane, a resonance frequency characteristic measurement unit which detects the alteration of the resonance frequency of said quartz oscillator, and a concentration calculation unit which converts the resonance frequency characteristic measured by said resonance frequency characteristic measurement unit into the alcohol concentration of said liquid fuel.

13. The fuel cell system according to any one of claims 8 to 12, wherein said polymer membrane includes a protonic acid group.

14. The fuel cell system according to any one of claims 6 to 13, further comprising a plurality of polymer membranes having different size alteration degrees with respect to temperature and pH,

wherein said concentration detection unit detects the alcohol concentration in said liquid fuel based on the respective size alteration degrees of said plurality of polymer membranes in consideration of temperature or pH of said liquid fuel in said container.

15. The fuel cell system according to any one of claims 1 to 14, wherein said polymer membrane is crosslinked.

16. The fuel cell system according to any one of claims 1 to 15, further comprising a cartridge detachable from the fuel cell main body,

wherein said container is provided in said cartridge.

17. The fuel cell system according to any one of claims 1 to 16, further comprising:

a fuel electrode tank which has a fuel injection inlet and supplies said liquid fuel to said fuel electrode; and

a cartridge which has a fitting unit to be fitted with said fuel injection inlet of said fuel electrode tank and is detachable from said fuel electrode tank,

wherein said container is provided in said cartridge.

18. The fuel cell system according to any one of claims 1 to 17, further comprising:

a different concentration fuel storage unit which stores a liquid fuel with a different alcohol concentration from that of said liquid fuel in said container;

a supply unit which supplies said liquid fuel to said container from said different concentration fuel storage unit; and

a control unit which adjusts the supply amount of said liquid fuel to be supplied by said supply unit depending on the alcohol concentration of said liquid fuel in said container detected by said concentration detection unit.

19. The fuel cell system according to claim 18, further comprising a fuel electrode tank which has a fuel injection inlet and supplies said liquid fuel to said fuel cell main body;

wherein said container includes a fitting unit to be fitted with said fuel injection inlet of said fuel electrode tank and a first connection unit for connection to said supply unit, said container being detachable from said fuel electrode tank and said supply unit, and said different concentration fuel storage unit includes a second connection unit for connection to said supply unit, said different concentration fuel storage unit being detachable from said supply unit.

20. The fuel cell system according to claim 19,

wherein said container and said different concentration fuel storage unit are unitedly formed.

21. The fuel cell system according to any one of claims 1 to 20, further comprising a temperature sensor which measures the temperature in said liquid fuel in said container,

wherein said concentration detection unit corrects the alcohol concentration of said liquid fuel in said container based on the temperature measured by said temperature sensor.

22. The fuel cell system according to any one of claims 1 to 21, further comprising a pH measurement unit which measures pH of said liquid fuel in said container,

wherein said concentration detection unit corrects the alcohol

concentration of said liquid fuel in said container based on the pH measured by said pH measurement unit.

23. The fuel cell system according to any one of claims 1 to 22, further comprising:

an alarm reporting unit which reports an alarm; and

a control unit which instructs said alarm reporting unit for reporting an alarm when the alcohol concentration of said liquid fuel in said container detected by said concentration detection unit is not within a predetermined range.

24. An alcohol concentration measurement apparatus, comprising:

a polymer membrane which has a proton conductivity, said proton conductivity being changeable when being immersed with an alcohol-containing liquid, in accordance with the alcohol concentration of said liquid; and

a concentration detection unit which detects the alcohol concentration of said liquid based on the alteration of the proton conductivity of said polymer membrane.

25. The alcohol concentration measurement apparatus according to claim 24,

wherein said concentration detection unit includes a pair of electrode terminals attached to said polymer membrane, a resistance measurement unit which measures the resistance value between the electrode terminals, and a concentration calculation unit which converts the resistance value measured by said resistance measurement

unit into the alcohol concentration in said liquid.

26. An alcohol concentration measurement apparatus comprising:

a polymer membrane which shows size alteration when an alcohol-containing liquid is immersed therewith, depending on the concentration of the alcohol concentration in said liquid; and

a concentration detection unit which detects the alteration degree of the size of said polymer membrane and detects the alcohol concentration of said liquid based on the alteration degree of the size.

27. The alcohol concentration measurement apparatus according to claim 26,

wherein said concentration detection unit includes a strain gauge attached to said polymer membrane, a resistance measurement unit which measures the resistance alteration of said strain gauge, and a concentration calculation unit which converts the resistance alteration measured by said resistance measurement unit into the alcohol concentration of said liquid fuel.

28. A method of measuring the alcohol concentration, comprising:

immersing an alcohol-containing liquid which is a target to be measured to a polymer membrane having a proton conductivity;

detecting the alteration of the proton conductivity of said polymer membrane; and

detecting the alcohol concentration in said liquid based on the alteration of the proton conductivity.

29. The method of measuring the alcohol concentration according to claim 28,

wherein said detecting the alteration of the proton conductivity includes measuring the resistance value of a pair of electrode terminals attached to said polymer membrane, and

wherein said detecting the alcohol concentration includes calculating the alcohol concentration of said liquid based on the resistance value.

30. The method of measuring the alcohol concentration according to claim 28 or 29, further comprising saturating said liquid with carbon dioxide gas before said detecting the alteration of the proton conductivity of said polymer membrane.

31. A method of measuring the alcohol concentration, comprising:

immersing an alcohol-containing liquid which is a target to be measured to a polymer membrane showing size alteration when being impregnated with said liquid;

detecting the size alteration of said polymer membrane; and

detecting the alcohol concentration of said liquid based on the size alteration of said polymer membrane.

32. The method of measuring the alcohol concentration according to claim 31,

wherein said detecting the size alteration includes measuring the resistance alteration of a strain gauge attached to said polymer

membrane, and

said detecting the alcohol concentration includes converting the resistance alteration measured in said measuring resistance into the alcohol concentration of said liquid.

33. The method of measuring the alcohol concentration according to claim 31,

wherein said detecting the size alteration includes measuring the electric capacity of a capacitor composed so as to sandwich said polymer membrane, and

said detecting the alcohol concentration includes detecting the size alteration of said polymer membrane based on the alteration of the electric capacity measured in said measuring the electric capacity, and converting the size alteration degree into the alcohol concentration of said liquid fuel.

34. The method of measuring the alcohol concentration according to claim 31,

wherein said detecting the size alteration includes measuring the alteration of resonance frequency of a quartz oscillator attached to said polymer membrane, and

said detecting the alcohol concentration includes detecting the size alteration of said polymer membrane based on the alteration of the resonance frequency measured in said measuring the resonance frequency, and converting the size alteration degree into the alcohol concentration of said liquid fuel.

35. A fuel storage container detachable to a fuel cell system which includes a fuel cell main body, a first electrode terminal, a second electrode terminal, and a voltage application unit which applies voltage between said first electrode terminal and said second electrode terminal, and reserving a liquid fuel supplied to said fuel cell main body, comprising:

a polymer membrane having a proton conductivity; and

a third electrode terminal and a fourth electrode terminal which are attached to said polymer membrane and electrically connected to said first electrode terminal and said second electrode terminal, respectively.

36. A fuel storage container detachable to a fuel cell system which includes a fuel cell main body, a first electrode terminal, a second electrode terminal, and a voltage application unit which applies voltage between said first electrode terminal and said second electrode terminal, and reserving a liquid fuel supplied to said fuel cell main body, comprising:

a polymer membrane changeable in size when being immersed with an alcohol-containing liquid;

a strain gauge which is attached to said polymer membrane; and

a third electrode terminal and a fourth electrode terminal which are electrically connected to said first electrode terminal and said second electrode terminal, respectively to output resistance alteration of said strain gauge.